

JCTVC-T0140: Enhanced QP offset signaling for adaptive cross-component transform in SCC extensions

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Summary

■ Enhanced QP signaling is proposed for Adaptive Cross-component Transform (ACT).

- Additional signaling of PPS/Slice-level QP offset values;
- Switching of QP offset values.

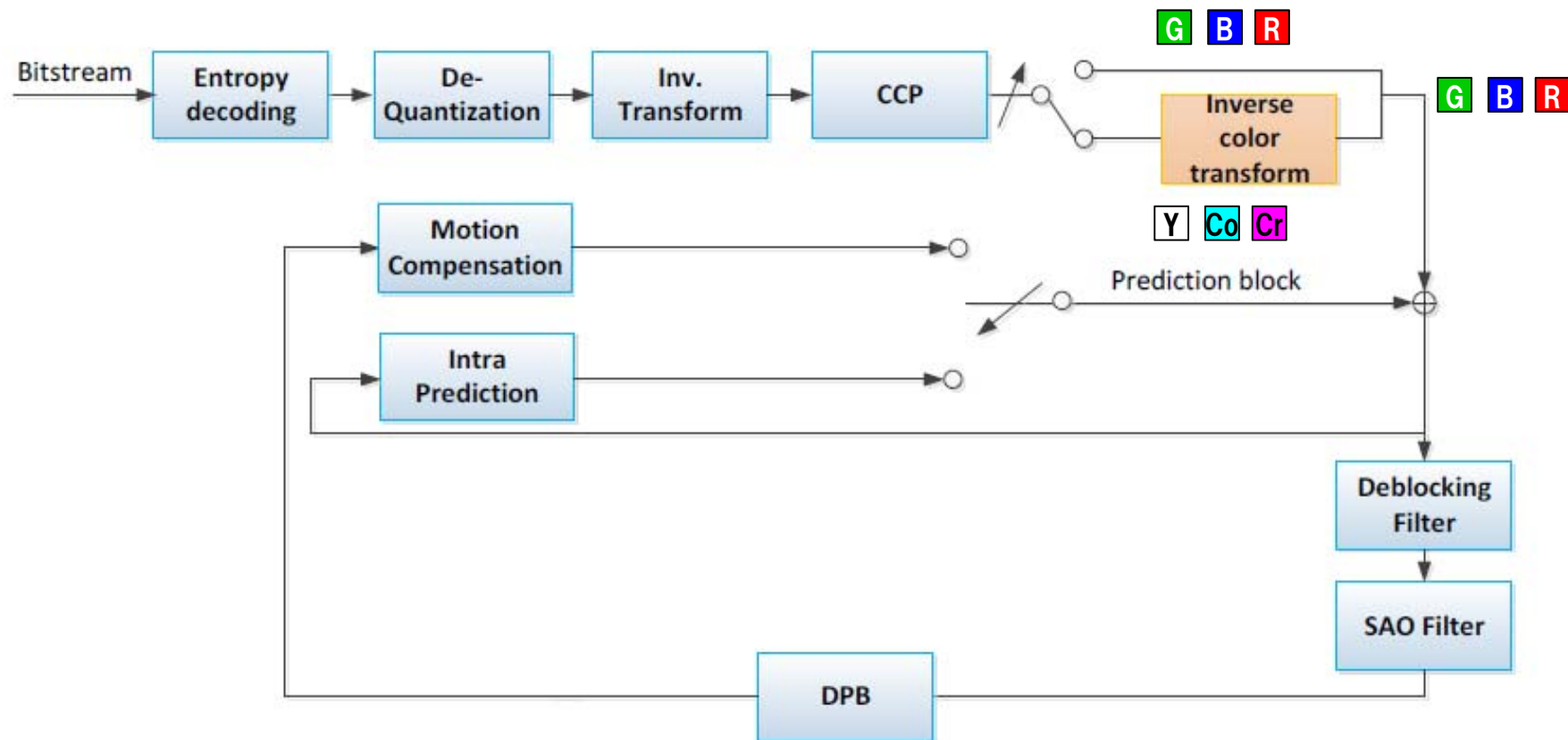
■ Simulation results shows:

- No impact in CTC
- Good gains in non CTC, in which the fidelity of G component is improved by using negative qp value in the region coded by using YCoCr color space.

■ It is recommended that proposal is adopted in the SCC extensions or studied in AHG toward the next meeting.

Background: Adaptive cross-component transform

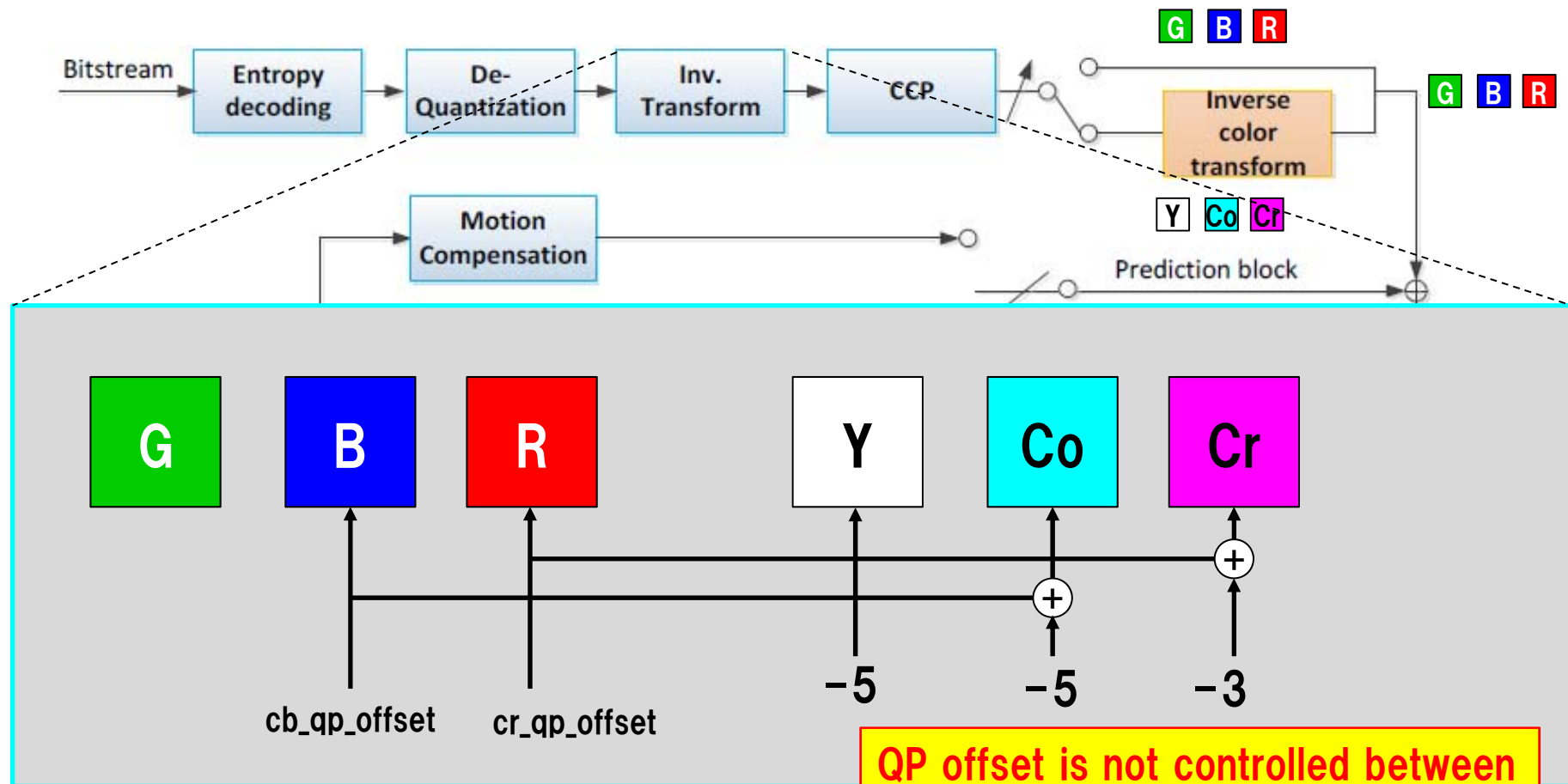
Prediction residual is adaptively represented either in RGB color space or YCoCr color space at CU level.



This figure is from JCTVC-R0147

Problem statement

Same chroma QP offsets values are applied to RGB prediction residual and YCoCr prediction residual.

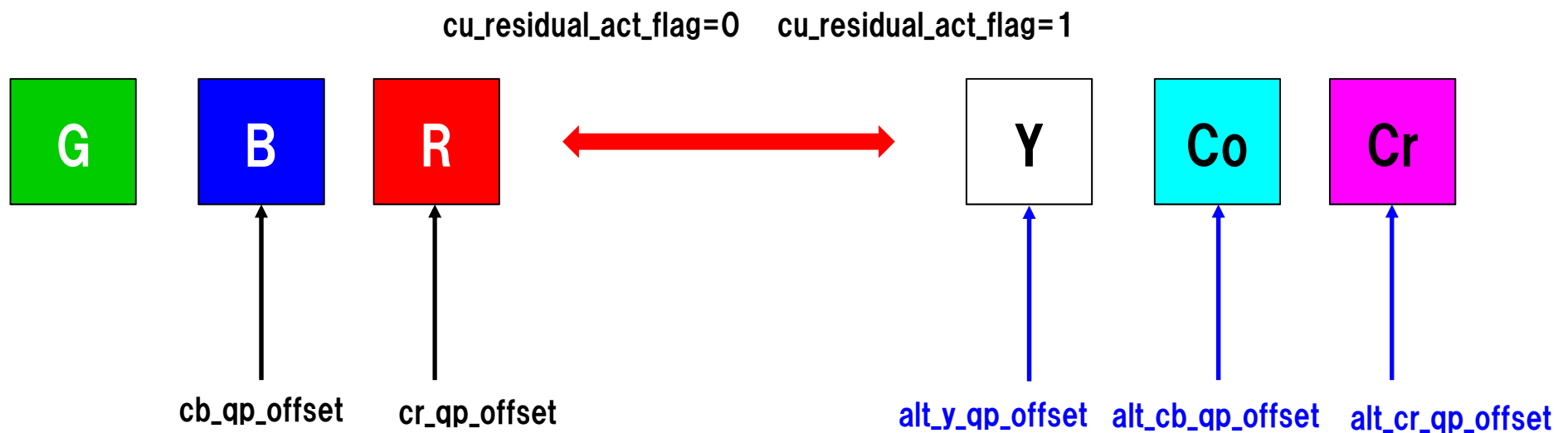


QP offset is not controlled between different color spaces!

Proposal

■ Use different QP offset values for different color-space prediction residues when ACT is enabled.

- Additional PPS/SPS-level QP offset signaling for ACT;
- QP offset switching based on ACT flag.



QP offset is controlled between different color spaces!

Detail of proposal (1/3)

PPS-level QP offset signaling

pps_scc_extension () {	Descriptor
residual_adaptive_colour_transform_enabled_flag	u(1)
if(residual_adaptive_colour_transform_enabled_flag){	
pps_slice_act_qp_offsets_present_flag	u(1)
pps_act_y_qp_offset_plus5	se(v)
pps_act_cb_qp_offset_plus5	se(v)
pps_act_cr_qp_offset_plus3	se(v)
}	
}	

Detail of proposal (2/3)

Slice-level QP offset signaling

slice_segment_header() {	Descriptor
first_slice_segment_in_pic_flag	u(1)
.....	
slice_qp_delta	se(v)
if(pps_slice_chroma_qp_offsets_present_flag) {	
slice_cb_qp_offset	se(v)
slice_cr_qp_offset	se(v)
}	
if(chroma_qp_offset_list_enabled_flag)	
cu_chroma_qp_offset_enabled_flag	u(1)
if(pps_slice_act_qp_offsets_present_flag){	
slice_act_y_qp_offset	se(v)
slice_act_cb_qp_offset	se(v)
slice_act_cr_qp_offset	se(v)
}	
.....	

Detail of proposal (3/3)

QP switching

[In the derivation process for quantization parameters (Section 8.6.1):]

When ChromaArrayType is not equal to 0, the following applies.

- If $\text{cu_residual_act_flag}[xTbY][yTbY]$ is equal to 0, the variables qP_{Cb} and qP_{Cr} are derived as follows:

$$qP_{Cb} = \text{Clip3}(-QpBdOffset_C, 57, Qp_Y + pps_cb_qp_offset + slice_cb_qp_offset + CuQpOffset_{Cb})$$

$$qP_{Cr} = \text{Clip3}(-QpBdOffset_C, 57, Qp_Y + pps_cr_qp_offset + slice_cr_qp_offset + CuQpOffset_{Cr})$$

- Otherwise ($\text{cu_residual_act_flag}[xTbY][yTbY]$ is equal to 1), the variables qP_{Cb} and qP_{Cr} are derived as follows:

$$qP_{Cb} = \text{Clip3}(-QpBdOffset_C, 57, Qp_Y + pps_act_cb_qp_offset + slice_act_cb_qp_offset + CuQpOffset_{Cb})$$

$$qP_{Cr} = \text{Clip3}(-QpBdOffset_C, 57, Qp_Y + pps_act_cr_qp_offset + slice_act_cr_qp_offset + CuQpOffset_{Cr})$$

[In the scaling and transformation process (Section 8.6.2)]

The quantization parameter qP is derived as follows:

- If $cIdx$ is equal to 0,

$$qP = \text{Clip3}(0, 51 + QpBdOffset_Y, Qp'_Y + (\text{cu_residual_act_flag}[xTbY][yTbY] ? pps_act_y_qp_offset + slice_act_y_qp_offset : 0))$$

- Otherwise, if $cIdx$ is equal to 1,

$$qP = \text{max}(0, Qp'_{Cb} - (\text{cu_residual_act_flag}[xTbY][yTbY] ? 5 : 0))$$

- Otherwise ($cIdx$ is equal to 2),

$$qP = \text{max}(0, Qp'_{Cr} - (\text{cu_residual_act_flag}[xTbY][yTbY] ? 3 : 0))$$

Simulation

■ Test1: Common test condition (QP offset value of 0)

- Reference: SCM-3.0 with --CbQpOffset=0 --CrQpOffset=0
- Tested: Proposal with --CbQpOffset=0 --CrQpOffset=0
--ActQpYOffset=-5 --ActQpCbOffset=-5 --ActQpCrOffset=-3

■ Test2: Not common test condition using QP offset value of -6

- Reference: SCM-3.0 with --CbQpOffset=-6 --CrQpOffset=-6
- Tested: Proposal with --CbQpOffset=0 --CrQpOffset=0
--ActQpYOffset=-5 --ActQpCbOffset=-11 --ActQpCrOffset=-9

It is intended that the fidelity of G component is improved by using the negative qp value only in the region coded by using YCoCr color space.

Test1 results: Common test condition

No impact on R-D results.

	All Intra		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
RGB, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
RGB, Animation, 720p	0.0%	0.0%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
YUV, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
YUV, Animation, 720p	0.0%	0.0%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%
Enc Time[%]	100%		
Dec Time[%]	101%		

	Random Access		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
RGB, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
RGB, Animation, 720p	0.0%	0.0%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
YUV, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
YUV, Animation, 720p	0.0%	0.0%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%
Enc Time[%]	100%		
Dec Time[%]	99%		

	Low delay B		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
RGB, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
RGB, Animation, 720p	0.0%	0.0%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	0.0%	0.0%	0.0%
YUV, mixed content, 1440p & 1080p	0.0%	0.0%	0.0%
YUV, Animation, 720p	0.0%	0.0%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%
Enc Time[%]	100%		
Dec Time[%]	100%		

Test2 results: Not common test condition

Proposal shows gains in G component since it does not spend too much bits in B and R information of the regions coded by using RGB color space.

	All Intra		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	-10.3%	2.4%	2.6%
RGB, mixed content, 1440p & 1080p	-9.8%	4.8%	5.4%
RGB, Animation, 720p	-12.9%	10.7%	9.0%
RGB, camera captured, 1080p	-37.9%	9.7%	2.9%
YUV, text & graphics with motion, 1080p & 720p	NA	NA	NA
YUV, mixed content, 1440p & 1080p	NA	NA	NA
YUV, Animation, 720p	NA	NA	NA
YUV, camera captured, 1080p	NA	NA	NA
Enc Time[%]	97%		
Dec Time[%]	97%		

	Random Access		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	-12.8%	4.1%	4.2%
RGB, mixed content, 1440p & 1080p	-20.2%	5.1%	5.6%
RGB, Animation, 720p	-19.8%	9.0%	8.9%
RGB, camera captured, 1080p	-37.0%	7.0%	-3.4%
YUV, text & graphics with motion, 1080p & 720p	NA	NA	NA
YUV, mixed content, 1440p & 1080p	NA	NA	NA
YUV, Animation, 720p	NA	NA	NA
YUV, camera captured, 1080p	NA	NA	NA
Enc Time[%]	95%		
Dec Time[%]	97%		

	Low delay B		
	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	-11.8%	6.3%	6.1%
RGB, mixed content, 1440p & 1080p	-21.1%	8.2%	8.8%
RGB, Animation, 720p	-24.3%	16.3%	17.4%
RGB, camera captured, 1080p	-43.0%	13.7%	1.8%
YUV, text & graphics with motion, 1080p & 720p	NA	NA	NA
YUV, mixed content, 1440p & 1080p	NA	NA	NA
YUV, Animation, 720p	NA	NA	NA
YUV, camera captured, 1080p	NA	NA	NA
Enc Time[%]	95%		
Dec Time[%]	97%		

Conclusion and recommendation

- Enhanced QP offset signaling for ACT is proposed.**
 - Additional signaling of PPS/Slice-level QP offset values;
 - Switching of QP offset values.

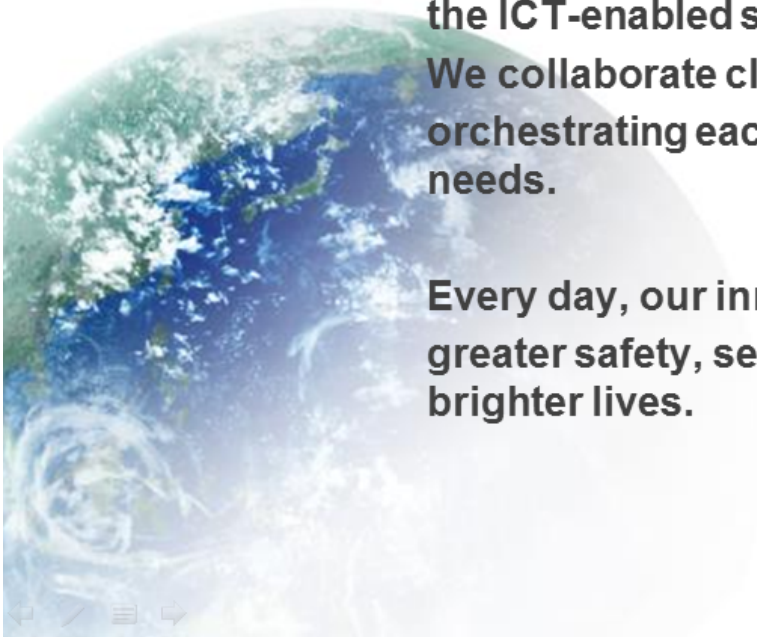
- Proposal is adopted in the SCC extensions or studied in AHG toward the next meeting.**

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